2014 CHINOOK SALMON SONAR ENUMERATION ON THE BIG SALMON RIVER

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Prepared by: B. Mercer and J.K. Wilson

J. Wilson & Associates
31 Donjek Road
Whitehorse, Yukon
Y1A 3P8

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ABSTRACT

A long range dual frequency identification sonar (DIDSON) was used to enumerate the Chinook salmon escapement to the Big Salmon River in 2014. The sonar was operated on the Big Salmon River for its tenth year at the same site used for the 2005 to 2013 projects; approximately 1.5 km upstream of the confluence of the Yukon River. Sonar operation began on July 11 and continued through to August 18. A total of 6,277 targets identified as Chinook salmon was counted during the period of operation, with 2 fish counted on the first day of operation and 15 fish counted on the last day of operation. Based on linear extrapolation of the last 7 days of sonar counts it is estimated a further 44 Chinook entered the system after sonar operation stopped. This yields a total estimated Chinook escapement of 6,321. The first Chinook salmon passing the Big Salmon sonar station was observed on July 11, the first day of operations. This was 4 days earlier than the earliest fish previously recorded (July 15 in 2005 and 2006). The peak daily count of 421 fish occurred on July 27, at which date 53% of the estimated run had passed the sonar station (10 days earlier than the 9 year average for 50% passage). Approximately 90% of the run had passed the station by August 6 (9 days earlier than average). The 2014 Big Salmon count of 6,321 Chinook salmon was 33% above the previous 9-year average passage estimate into the system of 4,758 Chinook.   Genetic stock identification sampling conducted at the Eagle sonar indicated the Big Salmon River stock group comprised 2.4% (s.d. = 2.1) of upper Yukon River Chinook salmon escapement in 2014. However, based on the Big Salmon and Eagle sonar counts of 6,321 and 63,431 respectively, the Big Salmon run comprised approximately 10% of the total above border escapement.

Carcass samples were collected between Aug 15 and Aug 25 over approximately 145 km of the Big Salmon River, yielding 143 Chinook salmon samples. Of the total, 73 (51%) were female and 70 (49%) were male. The mean MEF length of females and males sampled was 852 mm and 745 mm, respectively. All sampling data and scale cards were submitted to DFO Whitehorse stock assessment; scales were subsequently read by the Pacific Biological Station fish ageing lab. Complete age data was determined from 114 of the Chinook sampled; the remaining 29 samples yielded partial or no ages due to regenerate scales. Age-6 was the dominant age class of females (50%), followed by age-5 (4%) and age-7 (1%). Of the males, age-5 was the dominant age class (30%) followed by ages 6 (10%), 4 (4%) and 3 (2%).

INTRODUCTION

The 2014 Big Salmon sonar project marks the tenth year Chinook enumeration has been conducted on this system. The DIDSON sonar units used on the Big Salmon and other escapement enumeration projects have been found to be reliable and provide accurate counts of migrating salmon (Enzhofer et al. 2010, Holmes et al. 2006, Mercer & Wilson 2006 - 2014). Due to high flows and wilderness recreation use of the Big Salmon River, the utilization of traditional salmon weir techniques on this river is not feasible. For these reasons the DIDSON sonar was selected as a relatively low impact, non-intrusive method of accurately enumerating annual Chinook escapements to the Big Salmon River system. The use of sonar allows for enumeration of migrating Chinook salmon while minimizing negative impacts on fish behaviour and providing un-restricted recreational use of the river. This report is a summary of the 2014 project.

Based on the 2005 – 2014 sonar operations, the Big Salmon River has been shown to be a significant contributor to upper Yukon River Chinook production. The 2005 -2014 average sonar count is 4,914 (range 1,329 to 9,261). These counts represented an average of 10.5% of the total upper Yukon River Chinook spawning escapement point estimate for these years (Unpublished DFO Whitehorse data).

The goal of the program is to provide stock assessment information that will enhance the ability of salmon management agencies to manage Yukon River Chinook salmon. Quantifying Chinook escapement into upper Yukon River index streams allows for independent (from Pilot station and Eagle sonar project estimates) assessment of total above border Chinook escapements. Accurate Chinook escapement enumeration of select tributaries combined with stock composition information could generate upper Yukon River Chinook spawning escapement estimates within quantified statistical parameters.

In addition to the sonar operation, carcass sampling was conducted to obtain age, sex and length data from the 2014 Big Salmon Chinook escapement. This information provides important biological baseline data on the health of the stocks as well as information used in constructing future pre-season run forecasts.

Study Area

The Big Salmon River flows in a north-westerly direction from the headwaters at Quiet and Big Salmon lakes to its confluence with the Yukon River (Figure 1). The river and its tributaries drain an area of approximately 6,760 km^2, predominantly from the Big Salmon Range of the Pelly Mountains. Major tributaries of the Big Salmon River include the North Big Salmon River and the South Big Salmon River. The Big Salmon River can be accessed by boat either from Quiet Lake on the South Canol Road, from the Yukon River on the Robert Campbell and Klondike Highways, or from Lake Laberge via the Thirty Mile and Yukon rivers. The sonar site is at a remote location, approximately 130 air kilometers from Whitehorse. It is accessible by either boat or float plane.

Objectives

The objectives of the 2014 Big Salmon River sonar project were:

1. To provide an accurate count of the total Chinook salmon escapement in the Big Salmon River using a high resolution DIDSON sonar unit.

2. To conduct a carcass pitch on the Big Salmon River to obtain age-sex-length (ASL) data from as many post-spawned Chinook as possible with a target goal of 5% of the total run and document egg retention and principal recovery locations.

METHODS

Site selection

Sonar operations were set up at the same site used since 2005. This site, located approximately 1.5 km upstream from the confluence with the Yukon River (Figure 1), was initially selected for the following reasons:

- It is a sufficient distance upstream of the mouth to avoid straying or milling Chinook salmon destined for other headwater spawning sites.
- The site is in a relatively straight section of the river and far enough downstream from any bends in the river so that recreational boaters using the river have a clear view of the in-stream structures.
- The river flow is laminar and swift enough to preclude milling or 'holding' behaviour by migrating fish.
- Bottom substrates consist of gravel and cobble evenly distributed along the width of the river.
- The stream bottom profile allows for complete ensonification of the water column.
- The site is accessible by boat and floatplane.

The physical characteristics of the river at this site have not changed over the 10 years of sonar operation. It is anticipated that this site will continue to be used as long as the sonar program operates.

Permits

An application was submitted in 2005 to Transport Canada (Marine Branch), Navigable Waters Protection for approval to install partial fish diversion fences in a navigable waterway. Approval was granted for ongoing annual sonar operations as described in the original application.
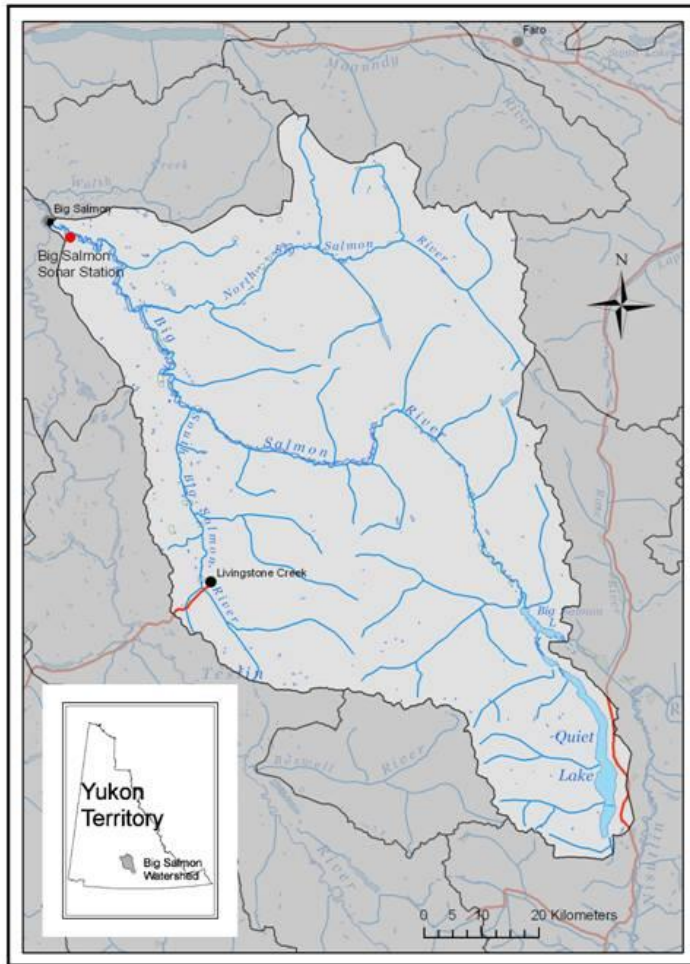
Figure 1. Big Salmon River Watershed and location of the 2014 Big Salmon sonar station.

Camp and Sonar Station Set-up

Due to the early run timing in 2014, project mobilization started on July 9. Initial access to the project site and transportation of associated equipment and supplies was by boat from Little Salmon Village.   Other supplies and personnel were transported from Whitehorse via floatplane. Subsequent camp access, crew changes, and delivery of supplies and fuel were accomplished either by riverboat or floatplane.

A five year licence of occupation was granted to the contractor in 2009 by the Yukon Territorial Government Lands Branch for the sonar camp (lower Big Salmon River, N 61°52' 45'', W 134° 53' 08''). This precluded the requirement of annual land use permits and allowed for the construction of upgraded and more permanent facilities at this site.   As in 2013 the camp was comprised of two wall tents and one cabin. The cabin was used primarily for storage and the tents were used for accommodation and to house the sonar and computer equipment.

Diversion Fence Construction

At the onset of the project, fence structures were placed in the river to divert shoreline migrating Chinook salmon into a 36 m migration corridor in the center of the river (Figure 2). Fence construction was initiated on July 10 and completed by July 11. Fence structures were constructed as in previous years using conduit panels and metal tripods stored on site.
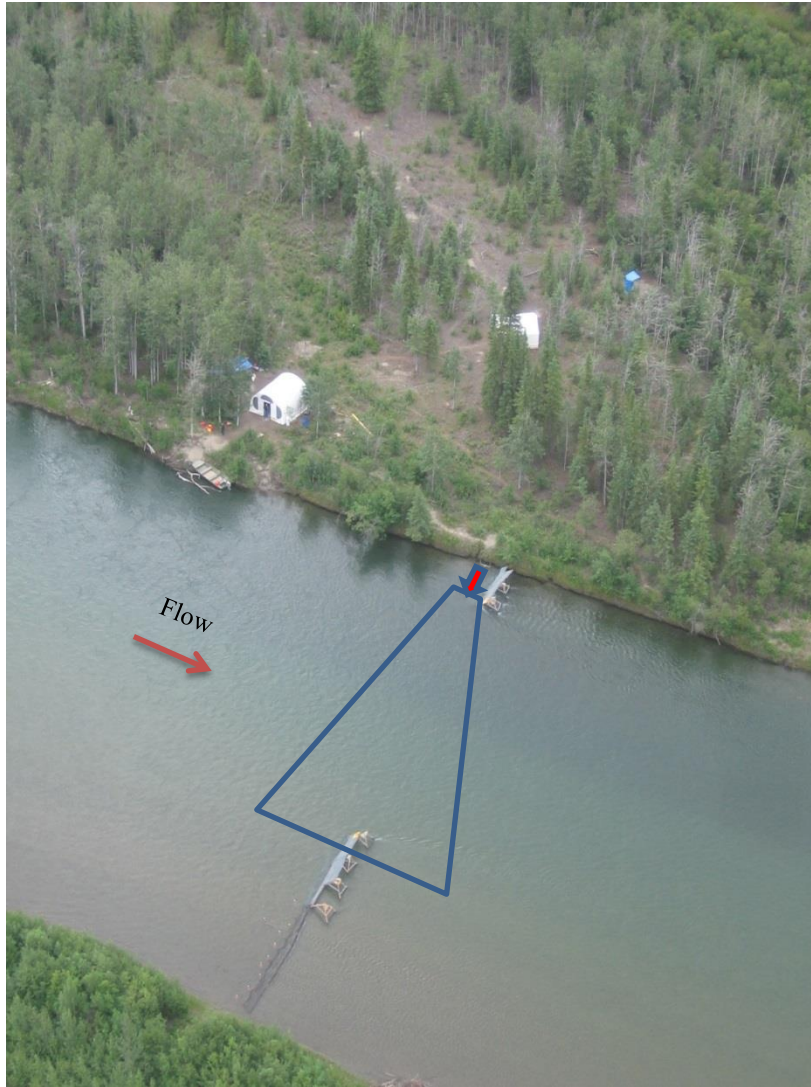
Figure 2. Aerial view of sonar station camp and partial weirs, (photo from 2010 project).
Blue outline denotes ensonified portion of the river.

River Profile

A boat mounted Biosonics DTX split beam sonar, aimed 90° down from the surface, was used to obtain a cross section profile of the river bottom at the sonar site. Data was collected from three bank to bank transects of the river. These transects were located 5m upstream, at the center and 5m downstream of the DIDSON sonar beams. The bottom profile was similar for all three transects. The cross section profile where the sonar was deployed is presented in Figure 3. The

cross section profile of the river bottom has remained relatively unchanged since the project started in 2005.
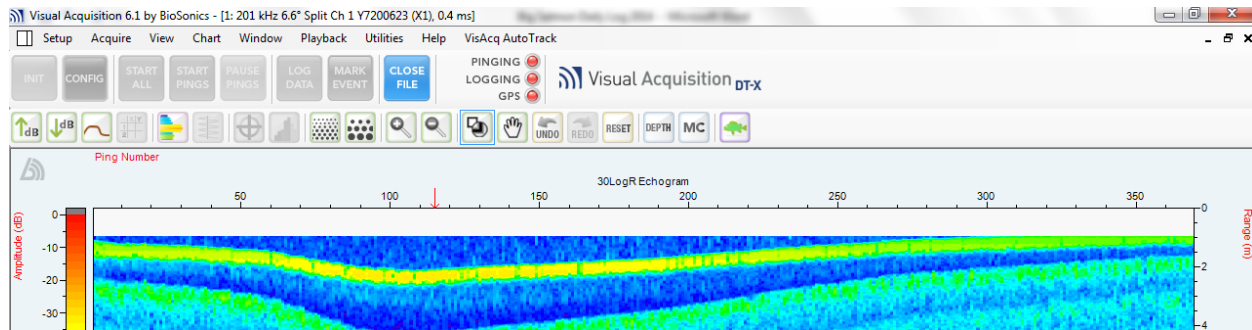
Figure 3. Cross section profile of Big Salmon River at sonar site using a Biosonics DTX split beam echo-sounder.

Note: Top of yellow line is river bottom, thalweg = 1.97 m. Transect view looking down river. The near field of the transducer prevents readings at depths less than 1m as indicated by the white band.

Sonar and Software Configuration

The sonar unit was placed next to the south bank at the site used in previous sonar operations (Figures 4). The configuration of the DIDSON sonar support apparatus was similar to that used in previous years at this site. The unit was mounted on an adjustable stand constructed of 2-inch steel galvanized pipe similar in design to those used at other DIDSON sonar projects (Galbreath and Barber 2005). The stand consisted of two T-shaped legs 120 cm in height connected by a 90 cm crossbar. The sonar unit was bolted to a steel plate suspended from the cross bar that was connected to the stand with adjustable fittings (Kee Klamps™). The adjustable clamps allowed the sonar unit to be raised or lowered according to fluctuating water levels as well as enabling rotation of the transducer lens to adjust the beam angle.

Figure 4. Sonar transducer unit and mounting stand in position. (Photo 2011)

The sonar system was powered by two sets of 6 gel cell batteries connected in two parallel circuits to create a 12 volt power source. The battery banks were charged by six 80 watt solar

panels and a backup 2.0 kW generator. An 800 watt inverter was used to obtain 110 volt AC from the batteries to supply power for the computers and the sonar unit. A rotating solar panel platform allowed the panels to be manually rotated to directly face the sun thereby increasing the efficiency of the solar panel array.

A concentrator lens has been attached to the sonar unit during its operation since 2009. This lens reduces the vertical ensonified field from 14° to 8°, thus increasing the resolution of all target images. The DIDSON sonar produces an ensonified field 29° wide in the horizontal plane and with the concentrator lens, 8° deep in the vertical plane. The DIDSON transducer lens was positioned at a depth of approximately 12 cm below the surface of the river and angled downward approximately 3º from horizontal resulting in the ensonified field of view remaining parallel to the surface of the river.

Using an 8° lens on a sonar unit deployed horizontally results in a beam depth of 1.05 m at a distance of 7.5 m from the sonar. The average water levels encountered in 2014 allowed for use of the concentrator lens throughout the project. A table was used from simple trigonometry formulae to enable the sonar operators to determine the beam depth for given water depths and sonar window start lengths (Appendix 1).

Once the sonar was in place and positioned, the primary sonar unit settings and software were configured. The receiver gain was set at –40 dB, the window start at 5.86 m, window length at 40 m, and auto frequency enabled for the duration of the project. The recording frame rate was typically set at 4 frames per second, which was the highest frame rate the computers could process with a window length setting of 40 m. Two laptop computers were used for the project, one recording the DIDSON files and one for reviewing the files. All files were saved and placed on a backup 500 GB external hard drive.

Sonar Data Collection

Sonar recording began on July 11 and continued until August 18. Sonar data was collected continuously and stored automatically in pre-programmed, 20 minute date stamped files. This resulted in an accumulation of 72 files over a 24 hour period. These files were subsequently reviewed the following day and stored on the active PC as well as backed up on the external hard drive.

To optimize target detection during file review, the background subtraction feature was used to remove static images such as the river bottom and weir structures. The intensity (brightness) was set at 40 dB and threshold (sensitivity) at 3dB. The playback speed depended on the preference and experience of the observer, but was generally set between 40 and 50 frames per second, approximately 8 to 10 times the recording rate. When necessary, the recording was stopped when a fish was observed and replayed at a slower rate for positive identification. Chinook salmon images were visually counted using a hand counter and the total count from each file was entered into an excel spreadsheet. A record of each 20 minute file count as well as hourly, daily and cumulative counts was maintained throughout the run.

The target measurement feature of the DIDSON software was used when required to estimate the size of the observed fish. All fish 50 cm and larger were categorized as Chinook.   The smallest sampled Big Salmon Chinook during the 2014 carcass pitch was 48.5 cm. Four of the 143 sampled fish (2.8%) had a MEF length less than 50 cm.   The largest target categorized as a resident fish based on size and swimming behaviour was approximately 30 cm.

Fish moving downstream identified as live Chinook were subtracted from each file total. It is assumed Chinook migrating downstream were strays. Straying of migrating salmon is not unusual and temporary[1] straying has been documented in telemetry studies of Yukon River Chinook (Eiler et al. 2006). The number of assumed strays detected is typically low and in 2014 amounted to 66 fish or 1.1% of the total run.

Precision of Fish Counts

It is standard practice in salmon enumeration sonar projects to review a sub-set of recorded data and apply an expansion factor to obtain a total estimate of fish passage. The variance associated with this expansion method can be quantified and incorporated into the total fish passage estimate (Enzenhofer et al., 2010; Crane and Dunbar 2007, 2010). For the Big Salmon sonar project, all recorded files were reviewed in their entirety so there was no variance associated with the expansion of a sub-set of a file data.

The precision of the file counts was measured by double reviewing a sub-set of all the files recorded. Precision refers to the repeatability of a count between different individuals for the same data file. Files for review were randomly selected from each day of sonar operation. Approximately 14% of the total files were reviewed by a second observer. The re-count from each file was recorded for comparison with the original.

The average percent error (APE) method can be used to quantify the repeatability (precision) of counts, particularly those counts with high fish passage rates (Enzenhofer *et. al,* 2010). This formula is expressed as:

$$APE = \frac{1}{N} \sum_{j=1}^{N} \left[\frac{1}{R} \sum_{i=1}^{R} \frac{\left| X_{ij} - \bar{X}_j \right|}{\bar{X}_j} \right] \times 100$$

where N is the number of events counted by R observers, Xij is the ith count of the jth event and Xj is the average count of the jth event.

However, because of the relatively low number of fish per hour in most of the Big Salmon sonar files, the percent error could be over-estimated. For example, if the first counter observed 2 upstream fish and the second counter missed one, the APE would be as high as 33%. This is because of the leverage that small numerical differences in low counts have on the overall calculation of APE. For this reason, the average percent error for this project was calculated using files with fish counts $\geq$ 5 fish/ file.

As well as calculating APE, a sample variance estimator based on the absolute difference between readers was used to quantify the precision of the counts and the net variability between readers.

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[1] Radio tagged Chinook were documented entering a tributary and subsequently retreating to the mainstem river and continuing their migration further up the system. Since the sonar station is located 1.5 km upstream from the confluence of the Yukon River the presence of straying Chinook could be expected.

Cross Section Distribution

The position of each Chinook observed within the cross section profile of the river was recorded in 5 m increments. This provided a range frequency histogram illustrating the cross sectional pattern of migrating Chinook.

Carcass Pitch

The upper reaches of the Big Salmon River were accessed using a 6.0 m open skiff powered by a 60 hp outboard jet motor. An initial carcass pitch trip was started on August 19 but had to be halted due to motor problems. After the motor was repaired, the crew made one extended trip upriver on August 22 through August 25. Carcass pitch efforts extended from the camp approximately 145 river kilometers to the first logjam located 20 km downstream from Big Salmon Lake. In addition to collection of ASL data, information was collected on the egg retention of the sampled females. The principal locations of the recovered carcasses and moribund fish were also recorded.

The carcass pitch involved collecting dead and moribund Chinook using a spear and sampling each fish. Carcass sampling consisted of collecting five scales per fish and placing them in prescribed scale cards. The sex and mid-eye-fork and post-orbital hypural lengths (to the nearest 0.5cm) were also recorded for each recovered fish.

RESULTS

Chinook Salmon Counts

The first Chinook salmon was observed on July 11, on the first day of operations. The peak daily count of 421 fish occurred on July 27, at which time 53% of the estimated run had passed the sonar station (10 days earlier than the 9 year average for 50% passage); 90% of the run had passed the station by August 6 (9 days earlier than average). Daily and cumulative counts are presented in Appendix 2 and Figure 5. A total of 6,277 targets identified as Chinook salmon was counted past the sonar station from July 11 through to August 18. Because the sonar was removed before the run was totally complete, the counts were estimated for an additional 6 days after sonar operations were stopped. This was done through extrapolation of the previous 6 days of the sonar counts based on the linear regression $y = -2.5429x + 31.4$. This extrapolation added 44 fish to bring the total count to 6,321.

The 2014 daily counts exhibited a normal distribution. The run timing was approximately 8 days earlier than the average run timing observed in the previous 9 years (Figure 5). Daily counts from 2005 through 2014 are in listed in Appendix 3.

Precision of Fish Counts

Of the 2,788 sonar files recorded and analysed, a total of 394 (14%) were reviewed by a second observer (Table 1). Of the 394 files reviewed, a total of 14 files (3.5%) exhibited a discrepancy between readers. Of the 14 files that exhibited inconsistencies between readers, an additional 16 fish were observed by the reviewer and 6 fish missed by the reviewer. This would yield a net gain of 10 fish for the 394 files that were reviewed. Expansion of this subset of files to cover the

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total number of files recorded would result in a possible total of 71 Chinook (1.1 % of the total run) that may not have been observed and counted.
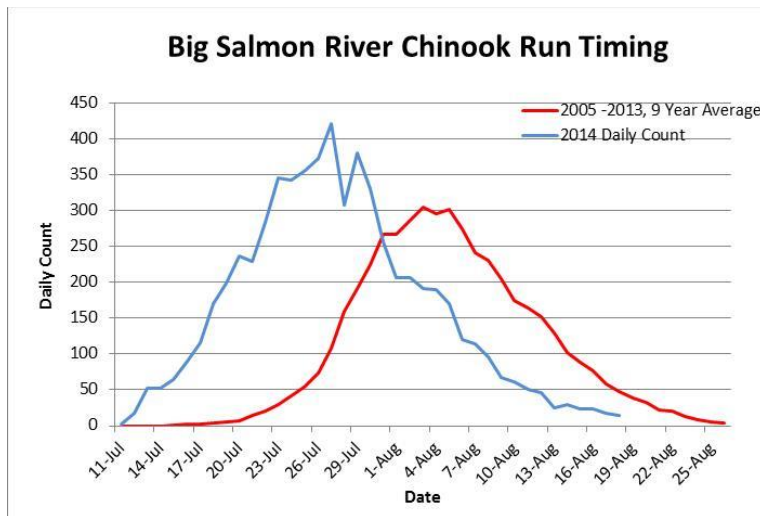
Figure 5. Daily counts of Chinook salmon passing the Big Salmon River sonar station in 2014 and 2005 through 2013.

Figure 6 illustrates the relationship between counts of 2 different file readers using daily pooled original and reviewed files. Linear regression between readers showed variation between counts but overall the correlation is high (R^2= 0.99).
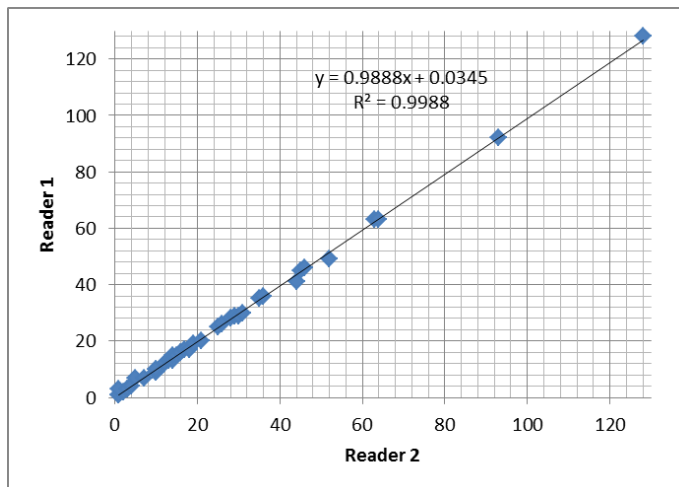
Figure 6. Linear regression between daily pooled sonar file counts that had been analysed by 2 different readers.

Note: Data points are daily pooled initial file counts (y axis) and reviewed file counts (x axis).

The average percent error (APE) was calculated for the 151 reviewed files that had fish counts ≥ 5 fish/file. The APE for this subset was 0.17%.

Table 1. Double reviewed files and calculated difference between counts.

	Count	%
Total files recorded during project	2,788	
Total files double reviewed	394	14%
Total fish counted in double reviewed files	1007	
Total files with + variance	10	3.1%
Total files with - variance	4	1.2%
Total Files with variance	14	4.3%
Total plus fish	16	+1.6%
Total minus fish	-6	-0.6%
Difference	+10	+1.0%

Cross Section Distribution

The cross sectional distribution pattern of the migrating Chinook as detected by the sonar is presented in Figure 7. The largest proportion of fish migrated near the south bank in deeper water at a distance of 15-20 meters from the sonar. It should be noted the distribution likely does not reflect the typical in-river migration pattern as the weir structures channel the fish into the 36 m wide opening.

The water levels experienced in 2014 were considered average which may account for the typical migration pattern. The water levels and temperatures recorded during the project are listed in Appendix 4.
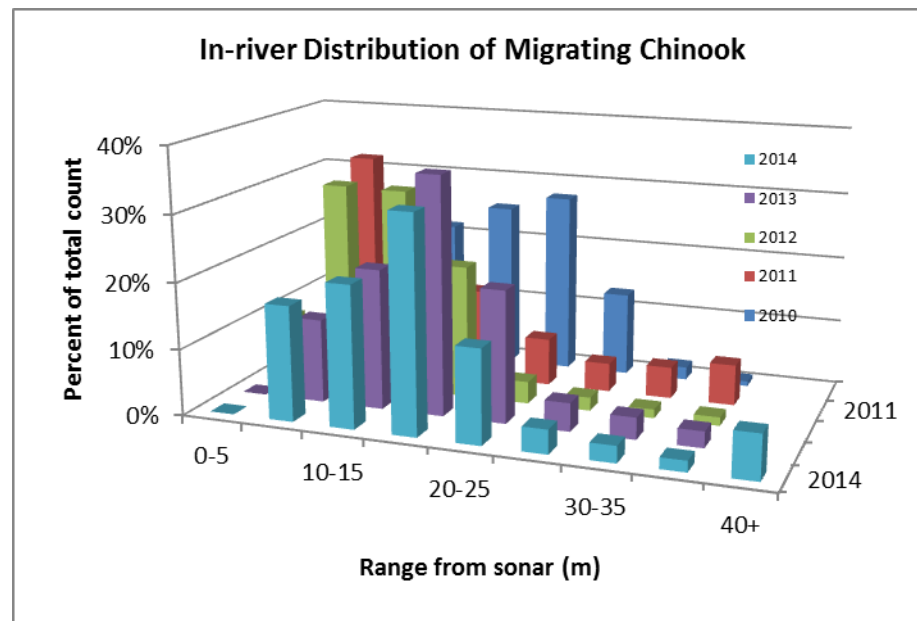
Figure 7. 2010 - 2014 Big Salmon River Chinook range/frequency in cross section profile.
 Note: The 0 – 7m range from the sonar has a deflection fence in place.

Carcass Pitch

A total of 143 dead or moribund Chinook was recovered during the carcass pitch. Of the fish sampled, 73 (51%) were female and 70 (49%) were male. The mean fork length of females and males sampled was 852 mm and 745 mm, respectively. The length frequency of Chinook

sampled is presented in Figure 8. Complete age data[2] was determined from 114 of the Chinook sampled; the remaining 29 samples yielded partial or no ages due to regenerate scales. Age-6 (1.4)[3] was the dominant age class of females (50%), followed by age-5 (1.3) (4%) and age-7 (1.2) (1%). Of the males, age 5 (1.3) was the dominant age class (30%) followed by ages 6 (1.4) (10%), 4 (1.2) (4%) and 3(1.1) (2%). Mean length and age data with complete age information is presented in Table 2.
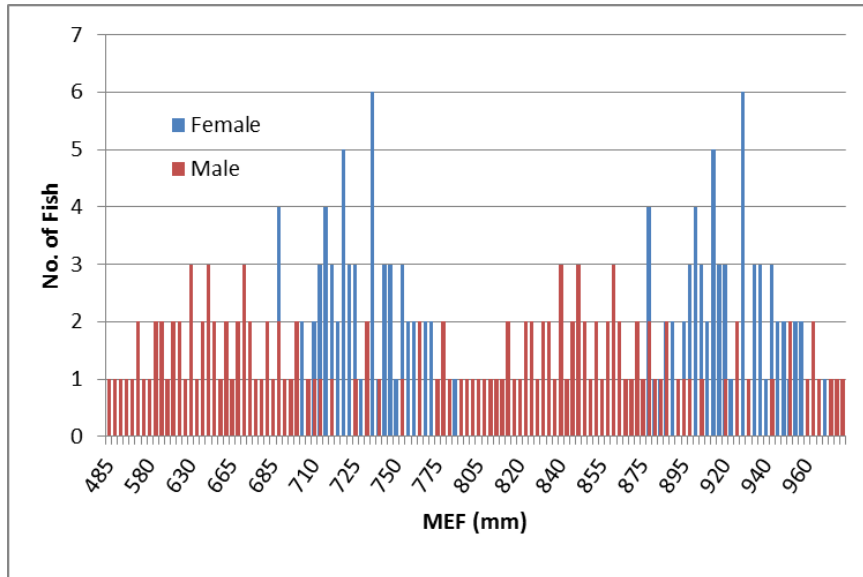
Figure 8. Length/frequency histogram of Big Salmon Chinook sampled in 2014.

Table 2. Age, length, and sex of Chinook sampled from the Big Salmon River, 2014.

SEX	AGE	Mean MEF	Count	%
Female	1.3	819	5	4%
	1.4	852	57	50%
	1.5	825	1	1%
Female total		848	63	55%
Male	1.1	533	2	2%
	1.2	610	4	4%
	1.3	737	34	30%
	1.4	837	11	10%
Male total		741	51	45%
Total		798	114	100%

Egg retention of sampled dead and moribund female Chinook was low. Of the 73 females sampled, two (2.7%) were not fully spawned out. The egg retention in these two fish was estimated to be approximately 50%. Complete age, length and sex data as well as egg retention and principal recovery locations are presented in Appendix 5.

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[2] Scale age analysis was conducted for DFO Whitehorse by the Pacific Biological Station, fish ageing lab in Nanaimo, British Columbia.
[3] European age format; e.g. 1.3 denotes a 5 year old fish with 1+ years freshwater residence and 3 years marine residence.

DISCUSSION

The 2014 Big Salmon sonar project was successful in enumerating the Chinook salmon passing the station and there is a high level of confidence the sonar count accurately reflected the Chinook escapement into the system.   Water levels were moderate throughout most of the season and the migration corridor of 36 m was maintained throughout the sonar operation. The DIDSON sonar unit and related power and computer equipment functioned well throughout the project. Short interruptions in sonar recording due to maintenance or power interruptions resulted in a total of 5 hours and 28 minutes recording loss over the course of the project.

The comparison of the counts of files reviewed by two different individuals exhibited a high degree of precision between both reviewers[4].   Repeated counts of the files were observed to produce the same counts 96.5% of the time for all files read. Average percent error of all the reviewed files was low (0.17%).   Since most of the discrepancies involved missed fish it can be surmised that sonar counts would be biased low. The variability between readers was not factored into the daily counts and the resultant potentially missed fish (71) were not added to the total sonar count.

The 2014 Eagle sonar project on the Yukon River downstream of the Canada/U.S. border yielded a spawning escapement[5] estimate of 63,331 Chinook salmon (DFO Whitehorse unpublished data 2015).   Based on both the Big Salmon and Eagle Chinook sonar counts, the Big Salmon stock contributed 10.0% of the total above border Chinook production in 2014.

Genetic stock identification (GSI) samples were also obtained at the Eagle sonar site using drift nets. The GSI data provides information on the stock composition of the total above border Chinook escapement.   The 2014 mean un-weighted proportional contribution of the Big Salmon River stock to the Chinook border escapement based on analysis of the GSI samples was 2.4%, (SD 2.1%) (DFO Whitehorse unpublished data). The 2014 proportional contribution of the Big Salmon River stock to the Chinook above border escapement based on analysis of the GSI samples was significantly lower than was observed from 2005 through 2013 (mean 9.0%; range 6.4%-14.0%). In addition, 3 years of radio telemetry studies (2002-2004) indicated the Big Salmon contribution to the Chinook above border escapement averaged 11.4% (range 9.2 – 15.1; Appendix 6). Moreover, as noted above, the 2014 GSI derived stock proportion is significantly lower than the proportion derived from the Big Salmon and Eagle Chinook sonar counts (10.0%).

Using Big Salmon sonar counts and the proportion of Big Salmon origin stock derived from the GSI sampling, an expanded Chinook border escapement estimate could be calculated. However, due to the relatively large standard deviation associated with the GSI derived stock proportion, the precision of the estimate would be poor and an expanded escapement estimate based on the Big Salmon count and GSI data would have limited value.   It is possible to obtain a Chinook border escapement with better precision based on analysis of the GSI samples and sonar counts from the Teslin sonar project. These results are presented in the 2014 Teslin River sonar project report (Mercer 2015).

To date, neither the Big Salmon/Eagle sonar counts nor the GSI based stock proportions serve as useful predictive indices on the run strength of the stocks. Appendix 7 illustrates the relationship between the Eagle sonar counts and the Big Salmon sonar counts from 2005 through 2014. As

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[4] Precision refers to the repeatability of a count between different individuals reading the same sonar file.
[5] Spawning escapement is the Eagle sonar count minus the catches in the U.S. above the sonar station and in the Canadian fisheries.

expected there is a relationship between the Big Salmon sonar counts and JTC estimates (mark/recapture and Eagle sonar), however, the relationship is non-significant ($R^2 = 0.61$). It can be expected that there will be inter- annual variance in the proportional contribution of the Big Salmon stock group to the total above border escapement as evidenced by the GSI and telemetry derived stock proportions (Appendix 6).

Appendix 8 illustrates the GSI based expansion of Big Salmon sonar counts and the JTC above border escapement estimates from 2005 to 2014. There is no significant correlation between the Big Salmon Chinook sonar counts and the calculated Big Salmon escapement estimates derived from the Eagle sonar count and GSI proportions ($R^2 = 0.28$). The low 2014 GSI derived estimate is an obvious outlier and is due to the relatively low 2014 GSI stock proportion (2.4%). Even with this outlier removed, the correlation has limited predictive value and does not yield sufficient precision to be used as an escapement index or to monitor long term trends for the system. Hence, neither the Big Salmon nor the Eagle sonar counts could be considered redundant in this context. More years of data and the elimination of suspected outlier years may increase the predictive precision of this method. It is worth noting that based on the Eagle and Big Salmon sonar counts, the Big Salmon stock GSI proportions appear to be biased low (Appendix 9). This may be a result of non-representative genetic sampling at Eagle and/or error in the genetic identification of the Big Salmon stock.

The number of samples collected in the 2014 carcass pitch was lower than expected. This was due in part to motor problems during the first carcass pitch trip. Repairs to the motor took four days, after which there was time for only one carcass pitch trip.

It is recognized that potential biases can occur with carcass sampling, just as biases can and do occur with all salmon sampling methods currently employed other than those that sample the whole population. Chinook dead pitch sampling bias has been examined in several studies (Mears and Dubois 2009; Zou 2002). Within a given year, carcass pitch sampling biases can be influenced by environmental factors (turbidity, flows), timing of data collection in relation to the die off period, inter-annual variation in age and sex structure of the population, sample size, sampling location and the experience of the samplers. As a generalization, age and sex compositions from survey samples underestimated the ages of small fish and males while overestimating those of large fish and females. Carcass pitch sampling is bias toward females because of their overall larger size and their propensity to live longer and stay on redds until they expire. Mears study indicated males were underrepresented in the carcass survey by 14% and females were overrepresented by 20% (Mears and Dubois 2009). Zou (2002) found in a multi-year study that males were under represented by 8% and females over represented by 12%. However, indications are that the population age class structures typically are representative of the population. In summary, the carcass survey data may be able to provide an adequate estimate of age class structure for each sex, but the numbers of individuals per sex may deviate from the whole population. It is worth noting those age classes that contribute the highest productive potential (age 5 and age 6) have the lowest probability of exhibiting age class sampling bias.

The Big Salmon program has been ongoing for ten consecutive years. There is value in maintaining an upper Yukon Chinook escapement monitoring project that provides accurate data over a long time series. The rationale for continuing this project is:
- It has proven to be a viable and consistent means of obtaining accurate escapement counts as well as age, sex and length data of Chinook salmon returning to the Big Salmon River.

- The Big Salmon stock comprises, on average, approximately 10 to 11% of the total upper Yukon Chinook escapement; the fourth highest stock composition behind the Yukon Mainstem, the Pelly and the Teslin systems.
- There is now one full generation of escapement data for the Big Salmon stock. Continuation of the project will provide ensuing recruitment information on those escapements. The development of biologically based escapement goals is typically based on stock recruitment modelling. These models are based on escapement estimates incorporating a long time series. The importance of long time series and continuous data sets related to escapement monitoring cannot be over emphasized. The data from this project has been an investment for the YRP and management agencies to date. To halt the project now will diminish the value of the investment the YRP and management agencies have put into the project to date.
- Big Salmon escapement information coupled with GSI stock composition data can provide an independent annual estimate of the total above border Chinook spawning escapement as well as provide information on the precision of the GSI stock proportions.

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Appendix 1. Sonar beam depth at tilt angles 0° – 45° and with start window lengths 6.7m and 7.5m.

8 Degree Lens								
Horizontal Beam			6.67 m start window			7.5 m start window		
Distance From Sonar (m)	Depth of Beam (m)	Width of Beam (m)	Tilt Degree @ 6.67m from sonar	Depth Added (m)	TOTAL DEPTH @ 6.67m (m)	Tilt Degree @ 7.5m from sonar	Depth Added (m)	TOTAL DEPTH @ 7.5m (m)
2.00	0.28	1.03	1.00	0.06	0.99	1.00	0.07	1.00
3.00	0.42	1.55	2.00	0.12	1.05	2.00	0.14	1.07
4.00	0.56	2.07	3.00	0.18	1.11	3.00	0.20	1.13
5.00	0.70	2.59	4.00	0.24	1.17	4.00	0.27	1.20
6.00	0.84	3.10	5.00	0.30	1.23	5.00	0.34	1.27
6.67	0.93	3.45	6.00	0.36	1.29	6.00	0.41	1.34
7.00	0.98	3.62	7.00	0.42	1.35	7.00	0.48	1.41
7.50	1.05	3.88	8.00	0.48	1.41	8.00	0.55	1.48
8.00	1.12	4.14	9.00	0.55	1.48	9.00	0.61	1.54
9.00	1.26	4.66	10.00	0.61	1.54	10.00	0.68	1.61
10.00	1.40	5.17	11.00	0.67	1.60	11.00	0.75	1.68
11.00	1.54	5.69	12.00	0.73	1.66	12.00	0.82	1.75
12.00	1.68	6.21	13.00	0.80	1.73	13.00	0.90	1.83
13.00	1.82	6.72	14.00	0.86	1.79	14.00	0.97	1.90
14.00	1.96	7.24	15.00	0.92	1.85	15.00	1.04	1.97
15.00	2.10	7.76	16.00	0.99	1.92	16.00	1.11	2.04
16.00	2.24	8.28	17.00	1.05	1.98	17.00	1.19	2.12
17.00	2.38	8.79	18.00	1.12	2.05	18.00	1.26	2.19
18.00	2.52	9.31	19.00	1.19	2.12	19.00	1.34	2.27
19.00	2.66	9.83	20.00	1.26	2.19	20.00	1.41	2.34
20.00	2.80	10.34	21.00	1.32	2.25	21.00	1.49	2.42
21.00	2.94	10.86	22.00	1.39	2.32	22.00	1.57	2.50
22.00	3.08	11.38	23.00	1.46	2.39	23.00	1.65	2.58
23.00	3.22	11.90	24.00	1.54	2.47	24.00	1.73	2.66
24.00	3.36	12.41	25.00	1.61	2.54	25.00	1.81	2.74
25.00	3.50	12.93	26.00	1.68	2.61	26.00	1.89	2.82
26.00	3.64	13.45	27.00	1.76	2.69	27.00	1.98	2.91
27.00	3.78	13.97	28.00	1.83	2.76	28.00	2.06	2.99
28.00	3.92	14.48	29.00	1.91	2.84	29.00	2.15	3.08
29.00	4.06	15.00	30.00	1.99	2.92	30.00	2.24	3.17
30.00	4.20	15.52	31.00	2.07	3.00	31.00	2.33	3.26
31.00	4.34	16.03	32.00	2.16	3.09	32.00	2.42	3.35
32.00	4.48	16.55	33.00	2.24	3.17	33.00	2.52	3.45
33.00	4.62	17.07	34.00	2.33	3.26	34.00	2.62	3.55
34.00	4.76	17.59	35.00	2.42	3.35	35.00	2.72	3.65
35.00	4.89	18.10	36.00	2.51	3.44	36.00	2.82	3.75
36.00	5.03	18.62	37.00	2.60	3.53	37.00	2.92	3.85
37.00	5.17	19.14	38.00	2.70	3.63	38.00	3.03	3.96
38.00	5.31	19.65	39.00	2.79	3.72	39.00	3.14	4.07
39.00	5.45	20.17	40.00	2.89	3.82	40.00	3.26	4.19
40.00	5.59	20.69	41.00	3.00	3.93	41.00	3.37	4.30
41.00	5.73	21.21	42.00	3.11	4.04	42.00	3.49	4.42
42.00	5.87	21.72	43.00	3.22	4.15	43.00	3.62	4.55
43.00	6.01	22.24	44.00	3.33	4.26	44.00	3.75	4.68
44.00	6.15	22.76	45.00	3.45	4.38	45.00	3.88	4.81
45.00	6.29	23.28						

Appendix 2. 2014 daily and cumulative counts of Chinook salmon at the Big Salmon River sonar site.

DATE	DAILY COUNT	CUMULATIVE	COMMENTS
Jul-11	2	2	sonar recording starts at 15:00
Jul-12	18	20	
Jul-13	52	72	
Jul-14	52	124	
Jul-15	64	188	
Jul-16	90	278	
Jul-17	115	393	
Jul-18	170	563	
Jul-19	199	762	
Jul-20	236	998	
Jul-21	229	1227	
Jul-22	284	1511	
Jul-23	345	1856	
Jul-24	343	2199	
Jul-25	356	2555	
Jul-26	372	2927	
Jul-27	421	3348	peak daily count
Jul-28	307	3655	
Jul-29	380	4035	
Jul-30	330	4365	
Jul-31	256	4621	
Aug-1	207	4828	
Aug-2	207	5035	
Aug-3	192	5227	
Aug-4	190	5417	
Aug-5	170	5587	
Aug-6	120	5707	
Aug-7	114	5821	
Aug-8	96	5917	
Aug-9	68	5985	
Aug-10	61	6046	
Aug-11	50	6096	
Aug-12	46	6142	
Aug-13	25	6167	
Aug-14	30	6197	
Aug-15	24	6221	
Aug-16	24	6245	
Aug-17	17	6262	
Aug-18	15	6277	sonar recording ends at 24:00
Aug-24		6321	Extrapolated count

Appendix 3. Daily and average Chinook counts in the Big Salmon River, 2005-2014.

DATE	Daily Count 2005	Daily Count 2006	Daily Count 2007	Daily Count 2008	Daily Count 2009	Daily Count 2010	Daily Count 2011	Daily Count 2012	Daily Count 2013	Daily Count 2014	Daily Average
11-Jul										2	2
12-Jul										18	18
13-Jul	0									52	26
14-Jul	0									52	26
15-Jul	2	1								64	22
16-Jul	12	0	2	0					0	90	17
17-Jul	13	1	0	0			2		0	115	19
18-Jul	23	0	2	0	0		7	0	0	170	22
19-Jul	13	0	5	1	11		13	0	0	199	27
20-Jul	23	1	5	0	22	0	15	0	0	236	30
21-Jul	36	3	7	0	47	7	24	0	1	229	35
22-Jul	58	8	11	0	68	14	24	0	1	284	47
23-Jul	92	11	18	1	85	12	43	0	2	345	61
24-Jul	130	21	26	2	135	7	44	0	4	343	71
25-Jul	158	20	52	1	201	12	50	1	3	356	85
26-Jul	204	53	88	3	226	14	56	1	11	372	103
27-Jul	219	95	153	5	346	27	105	1	25	421	140
28-Jul	287	146	237	9	498	46	160	3	44	307	174
29-Jul	290	230	287	9	532	83	192	15	86	380	210
30-Jul	299	321	337	29	594	123	218	12	83	330	235
31-Jul	279	368	400	21	808	141	218	23	150	256	266
01-Aug	333	357	435	23	578	159	260	62	196	207	261
02-Aug	346	379	331	18	715	182	313	76	220	207	279
03-Aug	303	358	304	16	725	216	417	138	264	192	293
04-Aug	292	413	258	31	595	226	426	156	262	190	285
05-Aug	331	496	210	51	559	215	396	196	261	170	289
06-Aug	214	490	178	55	452	221	400	228	225	120	258
07-Aug	188	464	147	78	364	227	317	192	191	114	228
08-Aug	232	464	59	61	295	242	294	235	195	96	217
09-Aug	234	360	74	70	270	248	243	183	156	68	191
10-Aug	203	349	90	98	209	183	160	154	132	61	164
11-Aug	124	348	82	122	183	207	170	106	134	50	153
12-Aug	126	324	98	107	146	174	143	130	113	46	141
13-Aug	125	243	77	109	118	181	100	110	101	25	119
14-Aug	72	196	74	89	117	134	85	81	77	30	96
15-Aug	57	180	66	78	65	114	89	80	65	24	82
16-Aug	40	172	56	70	55	82	63	94	57	24	71
17-Aug	53	104	40	49	63	80	35	70	34	17	55
18-Aug	47	69	64	45	55	53	20	50	32	15	45
19-Aug	35	87	37	17	43	40	18	44	21	14	36
20-Aug	29	59	47	18	35	24	21	38	28	11	31
21-Aug	26	45	11	15	28	18	11	27	20	9	21
22-Aug	19	50	16	16	14	38	2	19	10	6	19
23-Aug	17	12	23	9	4	24	2	19	14	3	13
24-Aug	13	10	17	2		20		14	11	1	11
25-Aug	9		14	1		17		9	6		9
26-Aug	6		14			6		6	4		7
27-Aug	4		13					5	2		6
28-Aug	2		11					3	1		4
29-Aug			9					2			6
30-Aug			8					1			5
31-Aug			6								6
01-Sep			4								4
02-Sep			3								3
TOTAL:	5618	7308	4506	1329	9261	3817	5156	2584	3242	6321	

Note: Stippled values were obtained through extrapolation of counts. Shaded areas denote start and end of sonar recording

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Appendix 4. 2014 Big Salmon River water and weather conditions.

DATE	TIME	AIR TEMP. (ºC)	WATER TEMP. (ºC)	WATER LEVEL (cm)	COMMENTS
11-Jul	9:00 AM	-	-	-	Mostly sunny
12-Jul	7:30 AM	11.0	12.0	60	Cloudy with sunny breaks and light showers
13-Jul	8:30 AM	11.0	13.0	58	Sunny with cloudy periods
14-Jul	8:30 AM	11.0	13.0	55	Mostly sunny
15-Jul	8:00 AM	10.0	13.5	52	Mostly sunny in morning with clouds developing in the afternoon
16-Jul	8:20 AM	9.0	13.5	49	Mostly cloudy
17-Jul	8:30 AM	10.0	13.0	45	Mostly sunny with thunder showers in the afternoon
18-Jul	7:40 AM	7.0	12.5	42	Mostly sunny with showers in the afternoon clearing in the evening
19-Jul	7:55 AM	6.0	13.0	41	Mostly sunny with showers in the afternoon.
20-Jul	8:05 AM	8.0	13.0	39	Mostly cloudy with light showers in the afternoon
21-Jul	8:30 AM	7.0	12.5	36	Cloudy in the morning clearing in the afternoon
22-Jul	7:50 AM	5.0	12.0	34	Sunny all day
23-Jul	7:40 AM	8.0	13.0	33	Sunny all day
24-Jul	7:00 AM	5.0	12.0	30	Cloudy with sunny breaks clearing in the evening
25-Jul	7:45 AM	7.0	13.0	27	Mostly cloudy with sunny breaks clearing in the evening
26-Jul	8:05 AM	6.0	11.5	25	Mostly cloudy
27-Jul	-	-	-	23	Mostly cloudy with thunderstorm - clearing in the evening
28-Jul	7:30 AM	5.0	11.5	22	Mix Sun and cloud, showers in evening, heavy rain overnight
29-Jul	7:50 AM	8.0	12.0	22	Cloudy with showers, rain all night
30-Jul	7:50 AM	8.0	12.0	25	Rain all day clearing in the evening
31-Jul	8:00 AM	7.0	11.0	65	Clearing in morning, sunny day. River rises to 85 cm by afternoon
01-Aug	8:10 AM	2.0	10.0	75	Sunny all day River drops to 65 by evening
02-Aug	8:10 AM	7.0	11.0	56	Sunny and hot.
03-Aug	7:50 AM	5.0	11.5	45	Mix of sun and cloud
04-Aug	8:00 AM	11.0	13.0	40	Mix of sun and cloud
05-Aug	8:10 AM	6.0	11.5	34	Mix of sun and cloud
06-Aug	8:00 AM	6.0	12.0	31	Mostly cloudy, small showers in the evening
07-Aug	7:50 AM	7.0	11.5	28	Mostly cloudy, afternoon showers, heavy wind/squalls, rain in evening
08-Aug	7:30 AM	7.0	11.0	26.5	Morning fog, mixed sun and cloud during day
09-Aug	7:30 AM	7.5	11.0	24	Overcast all day.
10-Aug	7:30 AM	8.0	11.0	21.5	partly cloudy in AM, Overcast in day
11-Aug	7:30 AM	12.0	12.5	20	morning cloud, then mostly sunny all day
12-Aug	7:30 AM	10.5	12.5	19	morning showers, clearing in afternoon
13-Aug	7:50 AM	6.5	12.0	18	Mostly cloudy with clearing in the evening
14-Aug	8:00 AM	8.0	12.0	18	Mostly cloudy with showers in the evening
15-Aug	7:45 AM	11.0	11.5	16	Mostly cloudy with a shower, clearing in the evening
16-Aug	8:30 AM	7.0	11.5	14	Sunny in morning then mostly cloudy with small showers.
17-Aug	8:05 AM	9.0	10.5	12	Cloudy with showers clearing somewhat in evening,
18-Aug	7:50 AM	8.0	10.0	13	showers and rain all day
19-Aug	8:30 AM	-	-	-	Rain in the Morning, leave for dead pitch

Appendix 5 (a).   Age, sex, and length of sampled Chinook on the Big Salmon River, 2014.

DATE	FISH #	SEX	% Spawned (Females)	MEF (mm)	POHL (mm)	AGE*	Recovery Site
15-Aug	1	M		710	625	1.3	13
19-Aug	2	F	N/A	785	685	1.4	1
19-Aug	3	M		740	655	1F	1
19-Aug	4	M		755	675	RG	1
19-Aug	5	F	N/A	885	790	1.3	1
19-Aug	6	M		620	540	1.3	1
19-Aug	7	M		805	735	1.3	1
19-Aug	8	F	N/A	820	725	1.4	1
22-Aug	9	M		945	820	1.4	13
23-Aug	10	M		580	515	1.1	13
23-Aug	11	M		920	805	1.4	13
23-Aug	12	M		765	690	1.3	1
23-Aug	13	M		720	625	1.3	1
23-Aug	14	M		530	455	1.2	1
23-Aug	15	M		710	620	1.3	1
23-Aug	16	M		635	550	1.3	1
23-Aug	17	M		950	845	RG	1
23-Aug	18	F	100	885	785	1.4	1
23-Aug	19	M		735	640	1F	2
23-Aug	20	M		920	805	1.3	2
23-Aug	21	M		835	730	1.3	2
23-Aug	22	M		820	710	M4	2
23-Aug	23	F	100	850	760	1.4	2
23-Aug	24	M		690	605	1.3	2
23-Aug	25	M		825	730	1.3	2
23-Aug	26	F	100	795	705	1.4	2
23-Aug	27	F	100	845	760	1.4	2
23-Aug	28	M		685	605	1.3	2
23-Aug	29	M		645	575	1.3	2
23-Aug	30	F	100	845	760	1.4	2
23-Aug	31	M		680	590	1.3	2
23-Aug	32	M		900	790	1.3	3
23-Aug	33	F	100	870	770	1F	3
23-Aug	34	F	100	725	640	1.3	3
23-Aug	35	F	100	930	810	RG	3
23-Aug	36	M		725	630	1F	3
23-Aug	37	F	100	930	820	1.4	3
23-Aug	38	F	100	870	765	1.4	3
23-Aug	39	M		750	660	1.3	3
23-Aug	40	M		785	700	RG	3
23-Aug	41	M		665	580	1.4	3
23-Aug	42	M		790	695	1.4	3
23-Aug	43	M		855	770	M3	3
23-Aug	44	M		730	650	1.3	3
23-Aug	45	M		645	570	1.3	3
23-Aug	46	M		795	705	1F	4
23-Aug	47	M		940	820	1.4	4
23-Aug	48	M		685	600	1.3	4
23-Aug	49	M		700	605	1.3	4
23-Aug	50	M		775	685	1.3	4

DATE	FISH #	SEX	% Spawned (Females)	MEF (mm)	POHL (mm)	AGE*	Recovery Site
23-Aug	51	M		705	620	1.3	4
23-Aug	52	M		785	695	1.4	4
23-Aug	53	M		630	555	1F	4
23-Aug	54	F	100	870	770	1.4	4
23-Aug	55	F	100	830	745	1.4	4
23-Aug	56	M		550	475	M2	4
23-Aug	57	M		655	570	1.3	4
23-Aug	58	M		705	615	1.3	4
24-Aug	59	M		715	620	1.4	5
24-Aug	60	F	100	815	725	1.3	5
24-Aug	61	F	100	850	750	1.4	5
24-Aug	62	M		485	425	1.1	5
24-Aug	63	M		735	640	1.2	5
24-Aug	64	M		865	760	1.3	5
24-Aug	65	F	100	855	755	1.4	5
24-Aug	66	M		865	760	1.4	5
24-Aug	67	M		665	580	1.3	5
24-Aug	68	M		635	555	1.2	5
24-Aug	69	M		960	855	1.3	6
24-Aug	70	M		1010	890	M4	6
24-Aug	71	F	N/A	810	725	1.4	6
24-Aug	72	F	100	N/M	735	1.4	6
24-Aug	73	M		815	730	1.3	6
24-Aug	74	F	100	895	800	1.4	6
24-Aug	75	M		945	830	M4	6
24-Aug	76	M		805	700	1.3	6
24-Aug	77	F	100	875	775	1.4	6
24-Aug	78	M		875	760	1.4	7
24-Aug	79	M		740	645	1.4	7
24-Aug	80	M		970	845	1.4	7
24-Aug	81	F	100	855	770	1.4	7
24-Aug	82	F	100	910	810	1.4	7
24-Aug	83	F	100	835	750	1.4	7
24-Aug	84	F	100	785	690	1.4	7
24-Aug	85	F	100	900	790	M4	7
24-Aug	86	F	100	830	745	1.4	7
24-Aug	87	F	100	870	780	1.4	7
24-Aug	88	F	100	850	755	M4	7
24-Aug	89	F	100	820	720	1.4	7
24-Aug	90	F	50	880	790	1.4	7
24-Aug	91	M		540	470	1.2	7
24-Aug	92	F	100	870	770	M3	7
24-Aug	93	F	100	925	825	1.4	7
24-Aug	94	F	100	905	795	M3	7
24-Aug	95	F	50	920	810	1.4	7
24-Aug	96	M		590	520	M2	7
24-Aug	97	F	100	955	850	1.4	7
24-Aug	98	F	100	825	750	1.3	8
24-Aug	99	F	100	N/M	745	1.4	8
24-Aug	100	F	100	845	755	1.4	8

DATE	FISH #	SEX	% Spawned (Females)	MEF (mm)	POHL (mm)	AGE*	Recovery Site
24-Aug	101	F	100	835	740	1.4	8
24-Aug	102	F	100	N/M	745	1.4	8
24-Aug	103	F	100	N/M	830	1.4	8
24-Aug	104	F	100	N/M	725	1.4	8
24-Aug	105	F	100	905	790	1.4	8
24-Aug	106	F	100	830	740	1.4	8
24-Aug	107	F	100	900	800	1.4	8
24-Aug	108	F	100	880	785	1.4	8
24-Aug	109	F	100	790	695	1.4	8
24-Aug	110	F	100	835	755	1.4	8
24-Aug	111	F	100	840	740	RG	8
24-Aug	112	F	100	N/M	670	M4	8
24-Aug	113	F	100	810	735	1.4	9
24-Aug	114	F	100	925	835	M4	9
24-Aug	115	F	100	845	760	1.4	9
24-Aug	116	M		685	610	M2	9
24-Aug	117	F	100	805	715	1.4	9
24-Aug	118	M		735	650	RG	9
24-Aug	119	M		670	580	M3	9
24-Aug	120	F	100	N/M	725	1.4	9
24-Aug	121	F	100	825	740	1.5	9
24-Aug	122	M		720	640	M3	9
24-Aug	123	F	100	840	750	1.4	9
24-Aug	124	F	100	910	820	1.4	9
24-Aug	125	M		705	610	1.3	9
24-Aug	126	M		765	670	1.3	9
24-Aug	127	M		670	585	1.3	9
24-Aug	128	F	100	830	755	1.4	9
25-Aug	129	F	100	845	740	1.3	10
25-Aug	130	F	100	885	780	1.4	10
25-Aug	131	M		700	625	M3	10
25-Aug	132	F	50	825	725	1.4	10
25-Aug	133	F	100	880	775	1.4	10
25-Aug	134	F	100	785	690	1.4	10
25-Aug	135	M		730	635	1.3	10
25-Aug	136	F	100	860	760	1.4	10
25-Aug	137	F	100	855	760	1.4	10
25-Aug	138	F	100	900	800	1.4	10
25-Aug	139	F	100	870	770	1.4	10
25-Aug	140	F	100	785	710	1.4	13
25-Aug	141	F	100	805	730	1F	13
25-Aug	142	F	100	730	645	1.4	13
25-Aug	143	M		590	500	1.3	13

*European age format; e.g. 1.3 denotes a 5 year old fish with 1+ years freshwater residence and 3 years marine residence

RG = Regenerate scale (center is missing from scale)
M = Marine stage
F = Freshwater stage
N/A = Partially decomposed or consumed, no assessment.
N/M = No measurement - fish partially consumed or decomposed

Appendix 5 (b).   Primary locations of sampled carcasses and moribund fish recovered on the Big Salmon River, 2014.

Recovery Site	* GPS Coordinates
1	N 61 45.392'
	W 134 37.701'
2	N 61 40.735'
	W 134 30.664'
3	N 61 38.066'
	W 134 29.019'
4	N 61 35.380'
	W 134 21.218'
5	N 61 32.739'
	W 134 12.157'
6	N 61 31.973'
	W 134 02.918'
7	N 61 31.668'
	W 133 58.003'
8	N 61 31.951'
	W 133 52.588'
9	N 61 37.071'
	W 133 45.705'
10	N 61 34.650'
	W 133 38.882'
13	N 61 52.461
	W 134 53.129

Appendix 6. Estimated proportion of Big Salmon River Chinook and Yukon River Chinook border escapement, 2002 through 2014.

| Year	Method	Estimated % proportion of border escapement based on telemetry or GSI sampling	Big Salmon sonar count	Border escapement based on Eagle sonar count or mark/recapture	Border escapement based on Big Salmon sonar count and GSI stock proportion
2002	Telemetry	9.2	n/a	n/a	n/a
2003	Telemetry	15.1	n/a	n/a	n/a
2004	Telemetry	10.0	n/a	n/a	n/a
2005	Fishwheel GSI Sampling	10.8	5,618	67,985 [c]	52,019
2006	Fishwheel GSI Sampling	9.7	7,308	62,630 [c]	75,340
2007	Fishwheel GSI Sampling	10.6	4,506	34,904 [b]	42,509
2008	Fishwheel GSI Sampling	9.3	1,431	33,883 [b]	15,387
2009	Gillnet GSI Sampling	16.9	9,261	65,278 [b]	54,799
2010	Gillnet GSI Sampling	11.7	3,817	32,010 [b]	32,624
2011	Gillnet GSI Sampling	9.2	5,156	50,780 [a]	56,043
2012	Gillnet GSI Sampling	6.7	2,594	32,658 [a]	38,104
2013	Gillnet GSI Sampling	6.6	3,239	28,669	49,136
2014	Gillnet GSI Sampling	2.4	6,321	63,331	263,375
Mean		11.3	4,770	45,422	61,757
Std. Dev.		3	2,278	15,259	65,681

[a] Eagle sonar above border spawning escapement estimate (DFO Whitehorse, unpublished data).

[b] Eagle sonar estimate (JTC 2012 and Unpublished DFO Whitehorse data).

[c] Mark/recapture estimate (JTC 2012).

Sources: Osborne et al. 2003; Mercer and Eiler 2004; Mercer 2005; JTC reports 2005 through 2012; unpublished DFO Whitehorse data.

Appendix 7. Big Salmon sonar counts and the JTC above border escapement estimates, 2005 – 2014.
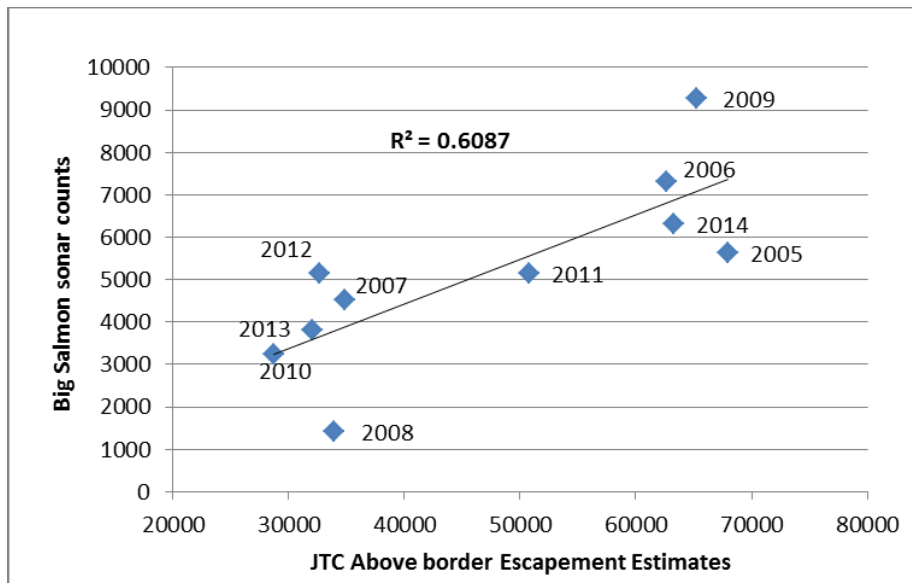
Appendix 8. GSI based expansion of Big Salmon sonar counts and the JTC above border escapement estimates, 2005 – 2014.
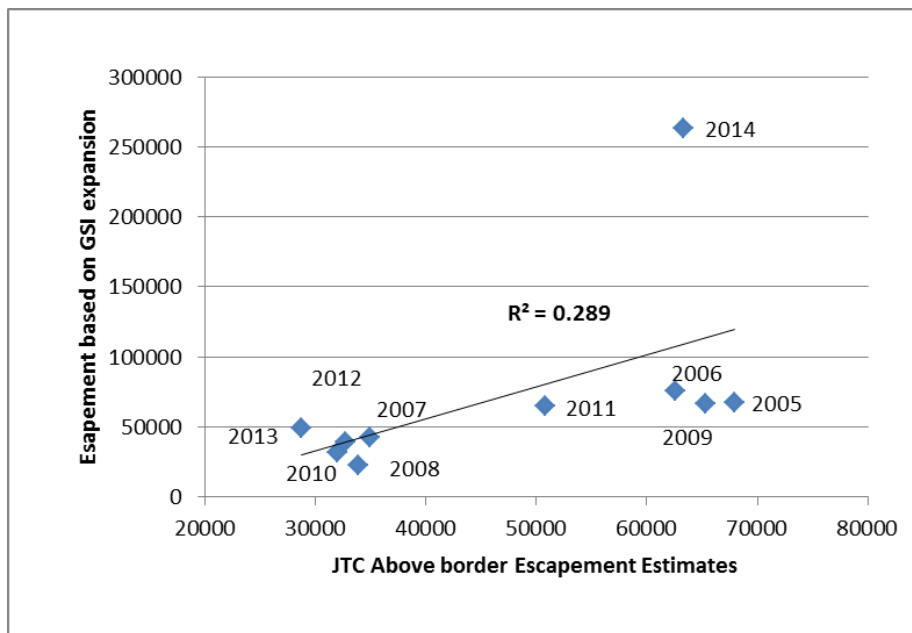
Appendix 9. GSI based estimates of Big Salmon Chinook escapements and comparisons with actual Big Salmon sonar counts, 2005 – 2014.

Year	GSI Stock Proportion	Big Salmon Sonar Count	Eagle-GSI generated estimate	Difference from sonar count	% Difference
2005	0.108	5618	7342	1724	30.7%
2006	0.097	7308	6075	-1233	-16.9%
2007	0.106	4506	3700	-806	-17.9%
2008	0.093	1431	3151	1720	120.2%
2009	0.169	9261	11032	1771	19.1%
2010	0.117	3817	3745	-72	-1.9%
2011	0.092	5156	4672	-484	-9.4%
2012	0.067	5156	3402	-1754	-34.0%
2013	0.066	3242	1892	-1350	-41.6%
2014	0.024	6321	1520	-4801	-76.0%
Mean	0.094	5282	5390	108	-0.03
SD	0.029	2319	2703	1437	0.53